CATALOGUE

OF

APPARATUS SUITABLE FOR LECTURES AND CLASS INSTRUCTION

IN

Subject 8.—Acoustics, Light, Heat.

Subject 9.—Magnetism and Electricity.

LONDON:
PRINTED BY GEORGE E. EYRE AND WILLIAM SPOTTISWOODE,
PRINTERS TO THE QUEEN'S MOST EXCELLENT MAJESTY.
FOR HER MAJESTY'S STATIONERY OFFICE.

1865.

13751.

INSTRUCTIONS.

All applications for apparatus are to be made on Science Form, No. 49, which will be supplied on application to the Secretary, Science and Art Department, South Kensington.

The prices given in the right-hand column are the highest on which the aid of 50 per cent. is given. The applicant is at liberty to select a higher-priced article, but the aid towards the purchase of it will be only 50 per cent. of the price in the right-hand column. Should a lower-priced article be selected the aid will be only to the extent of 50 per cent. of its price.

Apparatus grants are rigorously confined to articles of a permanent and non-destructible nature ; hence no aid is afforded in the purchase of breakable articles, such as glass retorts, test tubes, &c., or indeed generally in the purchase of articles to be used by the student as distinguished from those of a permanent and illustrative character which are required by the teacher in giving instruction in science.

ADDRESSES OF MANUFACTURERS :—

ELLIOTT BROS., 449 Strand.
GRIFFIN, 119 Bunhill Row.
HORNE & THORNTHWAITE, 121 Newgate Street.
LADD, 11 Beak Street, Regent Street.
NEGRETTI & ZAMBRA, 1 Hatton Garden.
NEWTON & Co., 3 Fleet Street.

PREFACE.

In the following Catalogue the figures in the column on the right show the estimated cost of the several pieces of apparatus. The size of the apparatus required, and consequently its cost, will now and then depend upon the number of the class to whom experiments have to be shown.

In many cases the apparatus advertized by instrument makers seems needlessly expensive, approaching more nearly to such as is wanted for original researches than to such as is most fitted for exhibition to a class. For example, all graduated instruments should be rather large models than real instruments for use ; circles and scales of mill-board, with large divisions on white paper, can be seen and appreciated by a class, when fine graduations on metal would be quite lost upon them.

In other cases, portions of some instruments may be made to serve for others, if the parts be made to fit. For example, when experiments have to be shown which require some rotating apparatus, such as Savart's experiments on musical notes, and various others on the production of electric currents, the same frame of multiplying wheels may be made to serve for all such experiments.

The chief difficulty in getting cheap apparatus lies in this, that workmen will finish all parts of an instrument to an equal degree, whether they be essential parts or of no importance. If the frame or stand is to be left rough they are always careless about the rest of the instrument ; spindles are not made true or are unequally weighted; tubulures which have to be fitted with corks are left with a projecting ridge on one side, so that no cork will stop the leakage ; or a screw on which something depends is put into the wood in the direction of the grain ; or some other trifling carelessness spoils the instrument and the first lecture at which it is exhibited—the whole of these very frequent annoyances arising from a want of consideration on the part of the workmen of the use to which their work is to be put. If they could be brought to concentrate their attention on making instru-

ments to work rather than for look, a great improvement might be made in the quality of some classes of instruments. It is almost needless to say, that instruments which do not perform with certainty, are no better than diagrams in a lecture room.

A great deal of apparatus is commonly made with fixed stands, whereas the lecturer often requires to be able to adjust it to different positions. It is therefore better in many cases that pieces of apparatus be provided with a rod of metal or wood which may be held in a clamp attached to a retort stand. *See* No. 44.

The numbers marked with a (‡) relate to apparatus which is not required for such parts of physics as are named in the syllabus given in the Directory, though they are capable of being made intelligible to a general audience, such as the human voice and polarized light—and may well form part of the instruction given in Science schools.

In cases where it is necessary to be independent of the sun as a source of light for experiments, the lime light is the most manageable substitute.

G. D. Liveing.

CATALOGUE.

GROUP III.

SUBJECT 1.—Acoustics, Light, Heat.

Acoustics.

	£	s.	d.
1.—Air-Pump.			
Tate's: Newton & Co., 3*l.* 13*s.* 6*d.*	3	13	6
,, Griffin, 3*l.*, 1*l.* 16*s.*			
Ladd, ditto.			
Elliott, ditto.			
N.B. This is probably the cheapest instrument which will answer the purpose of a lecturer. It is rather more laborious to work than an ordinary double-barrel pump, but the exhaustion is more complete.			
Air-pumps may be had from 1*l.* and upwards.			
2.—Alarum to be rung under exhausted receiver. (Bell experiment.)			
Elliott, 5*s.* 6*d.* to 1*l.* 1*s.*	0	5	6
Horne & Co., 7*s.* 6*d.* and 1*l.* 1*s.*			
Negretti, ditto.			
Newton, 5*s.* 6*d.*			
Ladd, 7*s.* 6*d.* and 1*l.*			
Griffin, 10*s.* and 1*l.* 0*s.* 6*d.*			
3.—Pasteboard cylinder (or square wooden tube) with moveable piston to show the effect of sounding boxes in increasing the intensity of sound.			
This apparatus may be made in a very simple way, and requires no stand but a wooden handle attached to the piston, and need not cost more than a few shillings. A wooden box with the ends open and a moveable plug will do.			
Elliott, 2*l.* 12*s.* 6*d.*	0	12	0
Ladd, 12*s.*			
4.—Apparatus to show the transmission of undulations in a tube.			
Consisting of a cylinder with curved lines traced upon it seen through a slit in a box in which the cylinder revolves.			
Elliott, 3*l.* 13*s.* 6*d.*	1	0	0
Horne & Co., ditto.			
This is a very simple piece of apparatus and might be made at a much less cost.			

	£ s. d.
5.—Monochord with two wires, one stretched by a weight and one by a screw. Elliott, 2*l.* 2*s.* to 7*l.* 7*s.* Horne & Co., 3*l.* 3*s.* to 5*l.* 15*s.* 6*d.* Ladd, 2*l.* 2*s.*	2 2 0
6.—Savart's toothed wheel apparatus.* Elliott, 9*l.* 9*s.* Horne & Co., 10*l.* 10*s.* Ladd, 1*l.* 1*s.*, without stand. An apparatus of this kind might probably be made in a less expensive manner. An octave of toothed wheels on the same axle and multiplying wheels of wood connected by straps are all that are really required for the lecture-room. See No. 67.	2 10 0
or **Siren.** Elliott, 3*l.* 13*s.* 6*d.* Horne & Co., 4*l.* 4*s.* Ladd, 2*l.* 10*s.*	
7.—Double bellows, and set of organ pipes. Elliott, 7*l.* 17*s.* 6*d.* Horne & Co., 10*l.* 10*s.* Ladd, 5*l.* 10*s.* This apparatus seems also more expensive than it need be. A small pair of double bellows with wind-box and holes for three or more pipes, and an assortment of pipes which may be shifted as required, would not cost nearly so much and would answer the purpose. One of the better class of German bird organs would probably answer.	4 4 0
8.—Two tuning-forks of different pitch. Ladd, 2*l.*	0 7 0
9.—Two do. in unison, with small mirrors attached. This apparatus is of limited use, as it can only be used with a strong light in a darkened room. Ladd, 3*l.*	0 12 0
‡10.—Apparatus to illustrate the action of the larynx. Elliott, 7*s.* 6*d.* Horne & Co., 10*s.* 6*d.* Ladd, 7*s.* 6*d.*	0 7 6
11.—Double clamp and glass plates, to show nodal lines. Elliott, 1*l.* 7*s.* Horne & Co., 1*l.* 11*s.* 6*d.* Ladd, 1*l.*	1 5 0

* Some lecturers may prefer a siren. More experiments can be made with Savart's apparatus. The delicate part of the apparatus for measuring exactly the rate of rotation is not needed in the lecture-rooms.

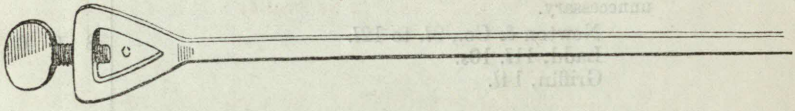
	£	s.	d.
‡12.—Hopkins' forked tube to show interference of sound.			
Elliott, 10*s.* 6*d.*	0	3	6
Ladd, 7*s.* 6*d.*			
N.B.—This is only a forked tube and may be made of pasteboard or tin plate.			
13.—Hydrogen bottle, to show the effect of a jet of gas burning in a tube.			
Elliott, 3*s.*	0	3	0
Griffin, 3*s.*			
Ladd, 5*s.* 6*d.*			
A common glass bottle, fitted with a cork, and hard glass tube drawn to a narrow opening will answer very well. See *Philosophical Magazine*, July 1857.			
14.—Glass tubes of different lengths and diameters to sound with the hydrogen jet.			
Griffin, 1*s.* 4*d.* per lb.	0	1	4
15.—Tin-plate speaking trumpet.			
Negretti, 5*s.*	0	5	0
Ladd, 5*s.*			
16.—Diagrams.	0	8	0
(1.) Table of velocities of sound in different media.			
(2.) Table of numbers of vibrations and lengths of waves in diatonic scale, standard pitch.			
Light.			
17.—Ritchie's Photometer.			
Elliott, 1*l.* 1*s.*	0	10	0
Ladd, 10*s.*			
This might be made for less.			
18.—Glass semi-cylinder, mounted at the centre of circle of pasteboard graduated, to show the laws of reflection and refraction.*			
Elliott, 18*s.* and upwards.	0	18	0
Ladd, 18*s.*			
19.—Set of lenses of different curvatures.			
These may be mounted in wooden rings with rods, so that they may be held by the universal holder No. 44.			
7 lenses and 7 halves, Griffin, 1*l.* 2*s.*	1	0	0
Newton & Co., 1*l.* 1*s.*			
Elliott, 1*l.* 16*s.* mounted.			
Ladd, 1*l.* 2*s.*			

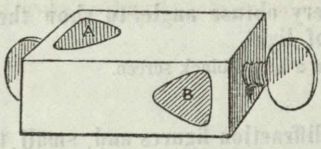
* Any plane mirror will do to show the law of reflection. That of refraction may be shown by three or four squares of tin plate painted black, with two white lines meeting in the centre at such angles that when one is the line of incidence for water, the other is that of refraction. If these be immersed in water up to the dotted line, the two lines will appear in one.

	£ s. d.
20.—Spherical concave and convex mirrors.	
These may be made with a projecting rod at back or side so as to be used with holder No. 44.	
Elliott, from 1*l.* 8*s.* Negretti, from 7*s.* 6*d.*, Ladd, 10*s.*	0 7 6
21.—Ground glass plate to receive images, with frame and foot.	
Black and white screens.	
These may be of pasteboard or wood, and made to slide into the same frame as the ground glass.	
Ladd, 10*s.*	0 10 0
22.—Triangular prisms of glass with plane ends.	
The faces should be abut 1½ inches long, and an inch wide at least. The angles may be conveniently 75°, 60°, and 45°.	
Elliott, from 1*s.* and upwards. Negretti, from 2*s.* Ladd, 10*s.* 6*d.*	0 10 6
23.—One prism of glass, with plane ends mounted at one end in brass, with rod for convenience in fixing in a horizontal position.	
Ladd, 12*s.* 6*d.*	0 12 6
24.—Prismatic bottle with two inclined plane faces, to show refraction of liquids.	
These are commonly used in spectroscopes.	
Elliott, from 10*s.* 6*d.* Ladd, 10*s.* Griffin, 5*s.* and 10*s.*	0 10 0
25.—Colour top, to show the effect of combining colours.	
Newton & Co., 10*s.* 6*d.*, Elliott, 1*l.* Negretti, 10*s.* 6*d.*	0 10 6
Or **Anorthoscope.** Newton, 1*l.* 5*s.*	
26.—Plates of coloured glass of different colours.	
Ladd, 4*s.*	0 4 0
27.—Complementary prisms of flint and crown glass.	
Negretti, 15*s.* Newton & Co., 12*s.* Ladd, 14*s.*	0 12 0
28.—Camera obscura, with ground-glass screen.	
Negretti, from 7*s.* 6*d.* Newton & Co., 1*l.* 16*s.* Elliott, 1*l.* 1*s.* Ladd, 10*s.*	0 7 6

	£	s.	d.
29.— Stereoscope, and a few geometrical slides.			
Negretti, 2*s.* 6*d.*	0	2	6
Ladd, 7*s.* 6*d.*			
30.—Heliostat.			
Elliott, 5*l.*	3	0	0
Ladd, 3*l.*			
Some instrument of this kind is indispensable where experiments with sunlight have to be shown to a class. All, however, that is really indispensable is a plane mirror, so mounted that it may be moved about two axes at right angles to one another, one of which is adjusted parallel to the earth's axis ; and the instrument must have a circle or cogged wheel, moveable by means of a tangent screw, so that the mirror may be rotated about the axis parallel to the earth's axis, without the necessity of perpetually opening the shutter in order to make the mirror follow the sun's motion. By a second mirror the light may be thrown in any convenient direction.			
31.—Apparatus for lime light, including lantern and condensing lens, gas bags, &c., complete.			
This will be wanted in cases where the sun cannot be used as the source of light, in which case the heliostat will be unnecessary.			
Newton & Co., 8*l.* to 12*l.*	8	0	0
Ladd, 11*l.* 10*s.*			
Griffin, 14*l.*			
‡32.—Prism, with very obtuse angle, to show the interference of light.			
This should be set in a broad black screen.			
Elliott, 5*s.*	0	5	0
‡33.—Photographic diffraction figures and small telescope.	1	10	0
‡34.—Apparatus for exhibiting Newton's rings.			
Elliott, 10*s.* and upwards.	0	10	0
Newton & Co., 10*s.*			
Ladd, 10*s.*			
‡35.—Two rhombs of Iceland spar.			
Negretti, from 5*s.*	0	10	0
Elliott, from 4*s.*			
Ladd, 12*s.*			
‡36.—Tourmaline forceps polariscope.			
Elliott, 10*s.* to 1*l.* 1*s.*	0	10	0
Negretti, do.			
Ladd, 15*s.*			
‡37.—Nicol's prism.			
Ladd, 9*s.*	0	7	6
Negretti, from 12*s.*			
Elliott, from 7*s.* 6*d.*			
Newton & Co., 16*s.* per pair.			

	£	s.	d.
‡38.—Airy's, or Norremberg's, reflecting polariscope. Negretti, 2*l.* Elliott, 2*l.* Ladd, do.	1	0	0
‡39.—Plates of quartz, aragonite, calcite, selenite, and nitre, and two or three pieces of unannealed glass, for the polariscope. Negretti, 4*s.* to 6*s.* Ladd, from 5*s.* each. Elliott, from 4*s.* to 8*s.*	1	5	0
40.—Diagram of the solar spectrum.	0	5	0
41.—Diagrams showing the course of rays reflected from curved mirrors, and refracted through lenses and prisms; and the formation of images.	1	0	0
42.—Diagrams of telescopes and microscopes, and of the eye.	1	10	0
‡43.—Powell's wave apparatus. Elliott, 3*l.* 13*s.* 6*d.* Ladd, 3*l.* 13*s.* 6*d.*	3	13	6





44.—A simple universal holder which will save the necessity for a stand in many cases may be adapted to a common retort stand. A block with two triangular perforations (A & B) at right angles to one another, may be clamped to the upright of a retort stand passed through (A), and a rod with a triangular eye (C) and clamping screw at one end may be passed through the horizontal perforation (B) of the block, and clamped in any position.

Four retort stands, which may be of different sizes, and as many holders, will generally suffice to hold all that is required at one time.

Griffin, 5*s.*
Ladd, from 3*s.* to 10*s.*

1 4 0

Heat.

45.—Ferguson's pyrometer, to show the expansion of different metal bars.

Elliott, 3*l.* 3*s.* to 5*l.* 5*s.*
Horne & Co., do.
Negretti, 3*l.* 10*s.*
Griffin, 1*l.* 11*s.* 6*d.*
Ladd, 3*l.* 3*s.*

1 11 6

	£	s.	d.
46.—Metal bar and gauge, to show expansion of metals by heat. Elliott, 7*s.* 6*d.* Horne & Co., 6*s.* 6*d.* Griffin, 4*s.* Ladd, 4*s.* 6*d.*	0	4	0
47.—Compound bar of brass and iron, to show the curvature resulting from unequal expansion. Elliott, 7*s.* 6*d.* Horne & Co., 10*s.* 6*d.* Ladd, 10*s.* (The stand is unnecessary.) Griffin's compound bar is riveted at the ends only, 2*s.*	0	7	6
48.—Thermometer tubes to illustrate the manufacture of thermometers. Horne & Co., 7*s.* Newton, 2*s.* 6*d.* Ladd, 2*s.* 6*d.* Griffin, 6*d.* each.	0	2	6
49.—Apparatus to show the force of contraction of solids (with 12 bars to be broken). Horne & Co., 15*s.* Griffin, 7*s.* Ladd, 7*s.*	0	7	0
50.—Differential thermometer (Rumford's best). Negretti, 15*s.* Horne & Co., 16*s.* Newton & Co., 14*s.* Ladd, 16*s.*	0	14	0
51.—Mercurial thermometers graduated on the stem. Elliott, 9*s.* to 1*l.* 1*s.* Griffin, 4*s.* to 6*s.* Ladd, 10*s.* Newton, 7*s.* 6*d.*	0	10	0
52.—Alcohol do. do. Elliott, 15*s.* Horne & Co., 1*l.* 1*s.* Ladd, 10*s.*	0	10	0
53.—Glass tubes of narrow bore, with large bulb at one end to show the expansion of gases. These may also be used as air thermometers. Griffin, 1*s.* 6*d.* each. Ladd, 3*s.* 6*d.*	0	4	6
54.—Cylindrical vessel of tin plate, glass or earthenware, with lateral tubulure near the top and bottom, into which thermometers may be fitted with corks, to show the temperature of water at the maximum density.	0	5	0

£ s. d.

55.—Six barometer tubes to show the elastic force of different vapours.

These must be ½ in. at least in diameter *internally*. See No. 14.

Griffin, 10*s*.
Newton, 6*s*.

0 10 0

56.—Wooden trough for mercury.

This may be made of one piece of mahogany about 9 in. by 4 in. by 3 in., and the trough cut out of it 7 in. long 2 in. deep, and 1 inch wide *at the bottom*, and 2½ in broad at top, one of the long slides being cut vertical and one sloping.

Ladd, 8*s*.

0 5 0

57.—20 lbs. mercury.

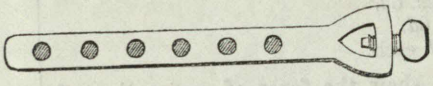
2 6 8

58.—Whalebone rod, 1 yard long, for removing air-bubbles in filling tubes with mercury.

Ladd, 1*s*.

0 1 0

59.



Wooden clamp, which may be fixed on to retort stand to hold such tubes, and which is a useful stand for other purposes, *e.g.* to hold funnels.

NOTE.—It may also be made as a vice. If the screw be of wood it should be inserted at right angles to the grain, and work at right angles to the length of the clamp, and not, as in the figure, in the direction of that length.

Ladd, 4*s*. 6*d*.

0 2 6

60.—Small earthenware evaporating dish with lip for filling tubes with mercury.

Ladd, 9*d*.
Griffin, 7*d*. to 10*d*.

0 0 7

61.—Cryophorus.

Elliott, 4*s*. 6*d*. to 12*s*.
Horne & Co., 3*s*. 6*d*.
Ladd, 3*s*. 6*d*.
Griffin, 2*s*. and 5*s*.

0 3 6

61a.—Carre's freezing apparatus.

This depends upon the rapid evaporation of liquefied ammonia. It was shown in the Industrial Exhibition, 1862, and illustrates both the liquefaction of gases by pressure, and the heat evolved by liquefaction, and the loss of heat which accompanies evaporation. Carré et Cie, Rue Ménilmontant, 149, Paris. Agent, J. R. Sheppard, 106, Leadenhall Street.

5 15 6

62.—Pneumatic syringe for showing the evolution of heat by compression of air.

Elliott, 4*s*. 6*d*.
Negretti, 3*s*. 6*d*.
Horne & Co., 3*s*. 6*d*.
Griffin, 3*s*.
Ladd, 3*s*.
Newton, 5*s*.

0 3 0

	£ s. d.
63.—Pair of concave tin reflectors (or copper silvered).*	
These should be 18 in. or 2 ft. in diameter at least. No stand is needed, but a short rod fixed at the back, by which it may be clamped.	
Elliott, 1*l.* 5*s.* and upwards.	1 5 0
Horne & Co., 2*l.* 2*s.* and upwards.	
Griffin, 1*l.* 11*s.* 6*d.*	
Ladd, 1*l.* 5*s.*	
Newton, 1*l.* 10*s.*	
64.—Iron ball and stand for use with reflectors.	
Elliott, 10*s.* 6*d.*	0 5 0
Horne & Co. 5*s.*	
Griffin, do.	
Ladd, do.	
Newton, 7*s.* 6*d.*	
65.—Two Leslie's cubical tin canisters.	0 4 0
Elliott, 10*s.* 6*d.*	
Horne & Co., ditto.	
Griffin, 3 cubes, 4*s.*	
Ladd, 4*s.*	
Newton, 4*s.*	0 15 0
66.—Thermo-multiplier.	
Elliott, 15*s.* and upwards.	
Ladd, do.	
Griffin, 48 pairs, 2*l.* 10*s.*	
67.—Multiplying wheel,† making a hollow copper cylinder rotate with considerable velocity to show the heat developed by friction; and which may also be used to show the heat developed when the rotation takes place between the poles of a powerful electro-magnet.	
Vide Professor Tyndall's lectures on Heat as a mode of motion.	1 10 0
Ladd, 1*l.* 10*s.*	
68.—Oak boards connected by hinge to produce friction with the foregoing machine.	0 3 0
Ladd, 3*s.*	
69.—Tin-plate vessel with several lateral tubulures into which rods of different substances may be fitted with corks, and heated with hot water or oil; to show different conducting powers.	0 5 6
Elliott, from 10*s.* 6*d.* to 1*l.* 1*s.*	
Horne & Co., 5*s.* 6*d.* to 10*s.* 6*d.*	
(Including bars of different metals.)	

* If the concave reflector, No. 20. be of copper silvered, it will do for the heat as well as light. As far as heat is concerned, tinned reflectors do quite as well as silvered, both require to be polished up with a little rouge before being used.

† Savart's toothed-wheels might be adapted to the same multiplying wheels.

	£	s.	d.
69a.—Wooden cylinder with broad brass ring to show the different conducting powers of brass and wood.			
Horne & Co., 2*s.* 6*d.* Ladd, 2*s.*	0	2	0
70.—Wire gauze for experiments on flame.			
Griffin, 1*s.* Newton, 2*s.*	0	1	0
71.—Safety lamp.			
Elliott, 9*s.* 6*d.* Horne & Co., 7*s.* 6*d.* Ladd, do. Griffin, 6*s.*	0	6	0
72.—Quart glass retort and receiver.			
Griffin, 2*s.*	0	2	0
73.—Daniel's or Regnault's hygrometer.*			
Elliott, 2*l.* 12*s.* 6*d.* Negretti, 2*l.* 12*s.* and 3*l.* 3*s.* Horne, 3*l.* 3*s.* Ladd, 10*s.* 6*d.*	0	10	6
74.—Large thin glass beaker, to show the currents produced by heating water.	0	1	0
75.—U tubes for like purpose, or Faraday's convection apparatus.			
Griffin, 3*s.* Elliott, 5*s.* Horne & Co., 5*s.* Ladd, 3*s.*	0	3	0
76.—Marcet's steam apparatus.			
Elliott, 3*l.* 10*s.* Horne & Co., 5*l.* 5*s.* Negretti & Zambra, 3*l.* 3*s.* to 4*l.* Griffin, 3*l.* 10*s.* Ladd, 3*l.*	3	0	0
77.—Sulphuric acid pan, to place under air-pump receiver.			
Griffin, 2*s.* to 3*s.* 6*d.*	0	2	0
78.—Two tin plates, one polished and one blackened, with supports for phosphorus at the back, to show difference of absorption.			
Griffin, 4*s.* Ladd, 4*s.* Newton, 4*s.*	0	4	0

* A model of Regnault's hygrometer, suitable for the lecture room, may be made at a very small cost:—A large test tube having the bottom part silvered by deposition, and containing a small spirit thermometer, fitted with a cork and two small glass tubes; air may be drawn through by an aspirator or blown through with a pair of bellows or gas-bag.

Diagrams.	£	s.	d.
79.—Gridiron and mercurial pendulums.	0	6	0
80.—Daniell's pyrometer.	0	5	0
81.—Roy and Ramsden's method of determining the coefficient of expansion of a metallic bar.	0	5	0
82.—Dulong and Petit's apparatus for determining the coefficient of expansion of mercury.	0	5	0
83.—Table of coefficients of expansion.	0	3	6
84.—The application of the force of contraction of cooling bars to bring together divergent walls.	0	5	0
85.—Apparatus for liquefying carbonic acid gas.	0	6	0
86.—Depretz' apparatus for comparing the conducting powers of solids.	0	5	0
87.—Regnault's apparatus for determining specific heats.	0	5	0
88.—Table of specific heats of common substances.	0	3	6
89.—Table of latent heat of fusion of common substances.	0	3	6
90.—Steam-engine.	0	10	0
91.—Joule's apparatus for determining the mechanical equivalent of heat.	0	5	0
92.—Regnault's apparatus for determining the tension of aqueous vapour.	0	6	0
93.—Comparative thermometric scales, showing Fahrenheit, Reaumur, and Centigrade scales, and the estimated scales of Daniell's and Brogniart's pyrometers.	0	3	6

Subject 2.—Magnetism and Electricity.

94.—Piece of magnetic iron ore. Elliott, from 1*s.* 6*d.* Negretti, do. Griffin, from 1*s.* Ladd, 2*s.* 6*d.*	0	2	6
95.—Two bar magnets at least 1 foot long, 1½ inches wide, and ½ inch thick. Elliott, bar magnets, from 1*s.* to 2*l.* 2*s.* Negretti, from 8*s.* 6*d.* to 1*l.* Griffin, 8-inch magnets, 3*s.* 6*d.* Ladd (in case), 13*s.*	0	13	0
96.—Horse-shoe magnet. Elliott, 10*s.* Ladd, do. Griffin, 10-inch, 4*s.* 6*d.*	0	10	0

	£	s.	d.
97.—Magnetic needle on vertical pivot. Elliott, from 5*s.* to 10*s.* Negretti, from 2*s.* 6*d.* Ladd, 3*s.* 6*d.* Griffin, 9-in. 7*s.*, 3-in. 4*s.*	0	5	0
98.—Dip-needle. Elliott, 12*s.* & 18*s.* Negretti, 1*l.* 10*s.* Newton, 15*s.* Ladd, 16*s.* Griffin, 4*s.* 6*d.* to 1*l.* 1*s.*	0	16	0
99.—Steel wire for extempore needles.	0	0	6
100.—Soft iron bars, and circular and star-shaped discs of sheet iron, to show the effects of induction. Elliott, 2*s.* to 10*s.* Ladd, 3*s.* 6*d.*	0	3	6
101.—Astatic needle. Elliott, 7*s.* 6*d.* Negretti, do. Ladd, do.	0	7	6
102.—Large electro-magnet, with armature. Elliott, 1*l.* 1*s.* to 3*l.* 3*s.* Griffin, smaller do., 10*s.* Newton & Co., 7*s.* 6*d.* Negretti, from 1*l.* 1*s.* Ladd, 1*l.* 1*s.*	1	1	0
‡103.—Bars of antimony, bismuth, and nickel.	0	4	6
104.—Maps showing the positions of the magnetic poles of the earth, magnetic equator, and isoclinic lines.	0	15	0
105.—Table of variations of declination since observations have been made.	0	3	6
Electricity.			
106.—Glass tube, one-half roughened to show the difference in the kind of electricity from the different surfaces. Horne & Co., 3*s.* 6*d.* Ladd, 3*s.* 6*d.*	0	3	6
107.—Stick of lac, or of pasteboard well covered with lac, or of vulcanite. Horne & Co., 2*s.* 6*d.* Elliott, 2*s.* to 7*s.* 6*d.* Griffin, 2*s.* Negretti, 2*s.* 6*d.* Ladd, 2*s.*	0	2	0

	£	s.	d.
108.—Plate electrical machine, 18 in. diam. at least. Horne & Co., 7*l.* 10*s.* Negretti, ditto. Newton, 6*l.* 6*s.* Elliott, 6*l.* 6*s.* and upwards. Ladd, 6*l.* 6*s.* Griffin, 4*l.* 14*s.* 6*d.*	6	6	0
109.—Amalgam. Horne & Co., 1*s.* Ladd, 1*s.*	0	1	0
110.—Pith balls. Horne & Co., 1*s.* per dozen. Griffin, 8*d.* Ladd, 8*d.*	0	0	8
111.—Unspun silk.			
112.—Battery of six Leyden jars of at least quart size, arranged so that they may be used either separately or together. Elliott, 1*l.* 5*s.* Horne & Co., 4 jars, 2*l.* 5*s.* Griffin, 6 jars, 1*l.* 18*s.* Negretti, 8*s.* 6*d.* per jar. Newton, 6 jars, 2*l.* 10*s.*	1	18	0
113.—Quadrant electrometer. Horne & Co., 4*s.* Griffin, 4*s.* 6*d.* Elliott, 3*s.* 6*d.* Negretti, 5*s.* Ladd, 4*s.* 6*d.* Newton, 3*s.* 6*d.* It should be moveable from the stand so that it may be attached to any electrified conductor. This will be easy if the stand be constructed on the principle of No. 118.	0	3	6
114.—Gold-leaf electroscope with condenser. Horne & Co., 12*s.* 6*d.* Griffin, 1*l.* 5*s.* Negretti, 16*s.* Ladd, 12*s.* 6*d.* Elliott, 15*s.*	0	12	6
‡115.—Roll of tin-foil on roller insulated and capable of being wound or unwound by an insulating handle, or a silk cord working like a roll blind. A simpler form of apparatus for the same purpose consists of two or more cylinders of tin plate which may be drawn out like a telescope. It must have insulating handles. A tin plate cup and a yard of brass chain which may be coiled in the cup or uncoiled by a silk thread will also answer.	0	10	0

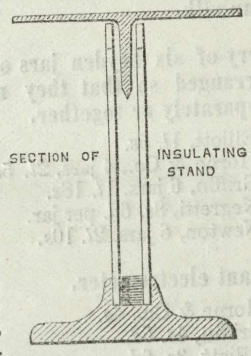
	£	s.	d.
‡116.—**Faraday's butterfly net, to show that electricity is distributed on the external surface of a conductor.**	0	1	6
117.—**Conductors of different forms of wood covered with tinfoil, to show the distribution of electricity and experiments on induction.**	0	6	0

If provided with a peg for the purpose, any one of these may be insulated by the stand mentioned below.

118.—**Brass chain, six yards.**	0	1	6

Horne & Co., 6*d.* per yard.
Ladd, 3*d.* per yard.
Newton, ditto.
Griffin, 6 yards, 1*s.* 9*d.*

119.—A convenient insulating stand may be made of a piece of stout glass tube fitted into a wooden foot, the bottom of the tube plugged with a mixture of rosin and beeswax, which will not crack, and the outside of the tube coated with lac. Anything which is provided with a peg which may be dropped into the open upper end of the tube may be insulated. A disc of wood with a peg will convert it into a small insulating table. Insulating handles may also be easily applied to anything provided with a ferule, into which a rod of gutta percha (or of pasteboard well coated with gutta percha or vulcanite) may be inserted.



Ladd, 7*s.* 6*d.*	0	7	6

120.—For heavy things thick sheets of gutta percha are convenient insulators.

121.—**Fulminating pane of glass, gutta-percha, or vulcanite.**	0	15	0

Elliott, glass pane, 15*s.*
Ladd, vulcanite, 16*s.*

122.—**Leyden jar with moveable coatings.**	0	10	6

Horne & Co., 14*s.*
Negretti, ditto.
Ladd, 10*s.* 6*d.*
Elliott, 10*s.* 6*d.*

123.—**Jointed discharger with insulating handle.**	0	5	0

Ladd, 5*s.*
Horne & Co., 7*s.*
Griffin, 4*s.* 3*d.*
Negretti, from 5*s.*
Newton, 6*s.* 6*d.*
Elliott, 7*s.* 6*d.*

	£	s.	d.
124.—Glass vessel mounted so that it may be exhausted with the air-pump, to show the discharge in rarefied air or gases.			
Horne & Co., 1*l.* 15*s.*	1	5	0
Negretti, ditto.			
Elliott, 1*l.* 5*s.*			
Ladd, 1*l.* 5*s.*			
Newton, ditto.			
125.—Electrophorus of vulcanite.			
A cover of tin plate does not work well as it will not remain truly plane.			
Horne & Co., 7*s.* 6*d.*	0	10	0
Negretti, 12*s.*			
Ladd, 10*s.*			
Elliott, 12*s.*			
126.—Whirl of pointed wire.			
Elliott, 2*s.* 6*d.*	0	2	6
Horne & Co., 3*s.* 6*d.*			
Griffin, 2*s.* 6*d.*			
Negretti, 3*s.* 6*d.*			
Newton, 3*s.*			
Ladd, 2*s.* 6*d.*			
127.—Six simple zinc and copper elements with wires, to show the simplest form of galvanic battery.			
Ladd, 2*s.*	0	2	0
128.—One Daniell's cell, 12 inches high.			
Horne & Co., 10*s.*	0	10	0
J. How, 12*s.*			
Elliott, 4*s.* 6*d.* to 14*s.*			
Griffin, quart size, 9*s.*			
Ladd, 10*s.*			
129.—One Smee's or Walker's pair, large size.			
Horne & Co., 1*l.* 1*s.*	0	12	6
Elliott, 15*s.*			
Negretti, 3 pt., 12*s.* 6*d.*			
Griffin, quart size, 9*s.*			
Ladd, qts., 10*s.*			
J. How, 12*s.*			
130.—Four lbs. mercury for amalgamating zinc plates, making connexions, &c.			
2*s.* 6*d.* per lb.	0	10	0
131.—Ten-celled Grove's or Bunsen's battery			
The platinum plates should be 6 in. by 3 in The Grove's battery is more expensive as to the first outlay but less so in working.			
Negretti, 5*l.* 5*s.* (Bunsen's.)	3	10	0
J. How, 3*l.* 10*s.*			
Ladd (Grove's), 5*l.* 10*s.*			
,, (Bunsen's), 3*l.* 10*s.*			
Griffin, (do.), 4*l.* 4*s.*			
Or Callan's ditto:—			
Horne & Co., 3*l.* 13*s.* 6*d.*			
Negretti, 4*l.* 4*s.*			
J. How, 3*l.* 3*s.*			
Elliott, 3*l.* 15*s.*			

	£	s.	d.
132.—Galvanometer multiplier, needle vertical.			
Elliott, from 1*l.* to 2*l.* 2*s.*	0	18	0
Ladd, 18*s.*			
Negretti, 7*s.* 6*d.* to 18*s.*			
Newton, 10*s.* 6*d.*			
133.—Pencils of gas carbon.			
J. How, 3*d.* per inch.	0	1	6
Ladd, 1*s.* 6*d.* per foot.			
134.—Fine wires of iron, copper, and platinum for deflagration.	0	3	0
135.—Henley's universal discharge, with holders for carbon electrodes or metal wires.			
Horne & Co., 1*l.* 12*s.* 6*d.*	1	5	0
Elliott, 1*l.* 5*s.*			
Newton, 1*l.* 5*s.*			
Griffin, 1*l.* 5*s.*			
Negretti, 2*l.* 2*s.*			
Ladd, 1*l.* 5*s.* and 2*l.*			
136.—Bent wire, capable of rotating about an axis in its own plane, for showing the mutual action of electric currents.			
This may be a wire bent into a parallelogram, hung by a fine thread, fixed at the middle of one side (or on a point), the two ends of the wire dipping into two separate circular grooves in the wooden foot of the stand, the grooves being filled with mercury.			
Ladd, 10*s.*	0	10	0
137.—Magnet capable of rotating about a current parallel to it.			
Elliott, 1*l.* 1*s.*	1	0	0
Griffin, 1*l.* 5*s.*			
Ladd, 1*l.*			
138.—Barlow's wheel, or Sturgeon's.			
Ladd, 10*s.*	0	7	0
Elliott, 18*s.*			
Griffin, 18*s.*			
Newton, 7*s.*			
139.—Apparatus to show the electrolysis of water.			
Horne & Co., 1*l.* 1*s.*	0	10	6
Negretti, 1*l.* 1*s.*			
Griffin, 2*s.* 6*d.* to 1*l.* 1*s.*			
Newton, 7*s.* 6*d.*			
Elliott, 10*s.* 6*d.* to 1*l.* 11*s.* 6*d.*			
Ladd, 10*s.* 6*d.*			
These apparatus are usually made too small for the lecture table. It is not necessary to have any special apparatus for the purpose, except some tolerably large platinum electrodes, not less than two square inches surface, soldered to a cord of copper wire well covered with gutta-percha. The gases may be collected in ordinary cylindrical gas jars inverted in a common earthen pan (or a glass milk pan), two or more strips of slate or pieces of tile being laid at the bottom to raise the jars above the conducting wires.			

	£ s. d.
140.—Three V tubes for showing electrolysis.	
Horne & Co., 7*s.* 6*d.* each. Negretti, 5*s.* Elliott, from 5*s.* 6*d.* Newton, 5*s.* Griffin, 4*s.* 6*d.* Ladd, 13*s.* 6*d.*	0 13 6
These may be merely bent glass tubes wired on to a foot of wood, with two strips of platinum foil for electrodes, which may be either soldered to long strips of thin sheet copper, or merely connected with such strips by the pressure of a cork cut through to receive them.	
141.—Copper wire coated with cotton, No. 14, 6 lbs. at 3s.	
Ladd, 3*s.* per 1lb.	0 18 0
142.—Ditto, No. 32, 3 lbs. at 8s. 6d.	
Ladd, 8*s.* 6*d.* per 1 lb.	1 5 6
This wire may be more completely insulated by covering it with gutta-percha by dipping it in a solution of gutta-percha in *cold* benzol.	
143.—Chain of alternate links of platinum and silver, to show the unequal heating effects of a current of electricity in the two metals.	
Elliott, 7*s.* 6*d.* Negretti, 6*s.* 6*d.* Horne & Co., 7*s.* 6*d.* Ladd, 6*s.* 6*d.*	0 6 6
144.—Six binding screws, to screw into blocks of wood, to connect apparatus.	
Negretti, 6*d.* each. Horne, 8*d.*	0 3 0
145.—Solenoid.	
146.—Floating battery carrying solenoid.	
Elliott, 5*s.* Negretti, 4*s.* 6*d.* Griffin, 7*s.* 6*d.*	0 4 6
147.—Astatic conductor in form of a double parallelogram of wire, to be adapted to the floating battery.	
148.—Induction coil, to illustrate electro-dynamic induction.	
Elliott, from 15*s.* to 1*l.* 11*s.* 6*d.* Griffin, 13*s.* Ladd, 13*s.*	0 13 0
149.—Bobbin of wire, to show induction by magnets.	
Ladd, 6*s.*	0 6 0
150.—Faraday's rotating needle.	
Negretti, 7*s.* 6*d.* Ladd, 7*s.* 6*d.* Griffin, 8*s.*	0 7 6

	£	s.	d.
151.—Magneto-electric machine.			
Elliott, from 2*l.* 10*s.* to 10*l.* 10*s.*	2	10	0
Newton, 2*l.* 12*s.* 6*d.*			
Negretti, 8*l.* 8*s.*			
Smaller do., 2*l.* 10*s.*			
Griffin, 2*l.* 15*s.*			
Ladd, 2*l.* 10*s.*			
‡152.—Thermo-electric pair of bismuth and antimony, V shaped, with wires for connecting it with a galvanometer. See No. 66.			
Ladd, 7*s.* 6*d.*	0	7	6
‡153.—Apparatus to show the currents of electricity produced in a copper disc rotating between the poles of a magnet.			
Elliott, 1*l.* 11*s.* 6*d.*	1	11	6
The rotating table No. 67, and the electro-magnet No. 101, may be used for this experiment.			
154.—Model of single needle telegraph.			
No. 132 if fitted with a commutator will do for this.			
Elliott, 18*s.* to 4*l.*	0	7	6
Griffin, 18*s.*			
Negretti, 3*l.* 3*s.*			
Ladd, 17*s.* 6*d.*			
Newton, 3*l.* 13*s.* 6*d.*			
155.—Rheochord, for illustrating electrical resistance.			
Ladd, 1*l.* 5*s.* to 1*l.* 15*s.*	1	5	0
156.—Diagrams.			
Table of the principal conductors and insulators in the order of their conducting power.	0	3	6
Table of substances which become electric by friction, arranged in order so that each is positive with reference to those below it.	0	3	6
Torsion balance.	0	5	0
Diagram showing the electric density in bodies of different shapes.	0	5	0
Table of specific inductive capacities.	0	3	6
Diagram to illustrate "polarization."	0	4	0
Table of differences between the electromotive force of several metals and that of platinum.	0	3	6
Table of metals in order so that when formed into thermo-electric pairs each is positive with reference to those that follow.	0	3	6
Thermo-electrometer.	0	5	0

LONDON:
Printed by GEORGE E. EYRE and WILLIAM SPOTTISWOODE,
Printers to the Queen's most Excellent Majesty.
For Her Majesty's Stationery Office.

[9589.—500.—11/65.]